J/ψ in sPHENIX

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Overview

Inclusive J/ψ

- *The main idea is to apply electron p_T cut 2 GeV/c and look only at high p_T J/ψ*
- *Background calculated using the same code as was used for Upsilons, see my presentation on September 6, 2016:*
  https://indico.bnl.gov/materialDisplay.py?contribId=1&materialId=slides&confId=1926
- *Only combinatorial background considered.*

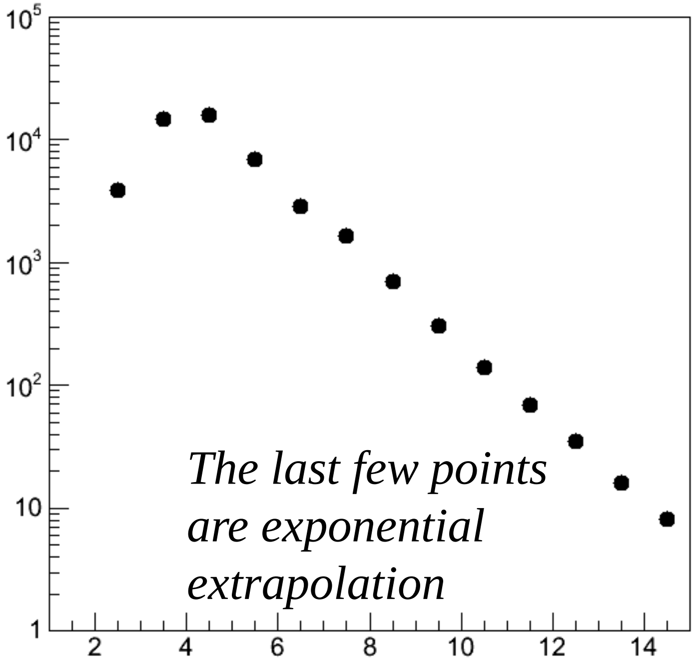
B $\rightarrow$ J/ψ using DCA and secondary displaced vertex *(PHG4TrackKalmanFitter)*

Expected J/ψ yield

Number of 0-10% central AuAu events	10e+09
N_{COLL}	955
σ_{pp}	40 mb
B_{ee} x $\sigma_{J/\psi}$	180 nb*
R_{AA} for J/ψ	0.3*
Acceptance (PYTHIA)	0.224 (integrated over p_T)
eID efficiency	0.9
Tracking efficiency	100%
Number of reconstructed J/ψ in acceptance	2.6e+06
p_T > 2 GeV cut efficiency	1.7% (integrated over p_T)

* ppg104; Phys. Rev. D85, 092004 (2012)

Expected number of J/ψ in 10B 0-10% central Au+Au collisions



Transverse momentum [GeV/c]

Simulation details

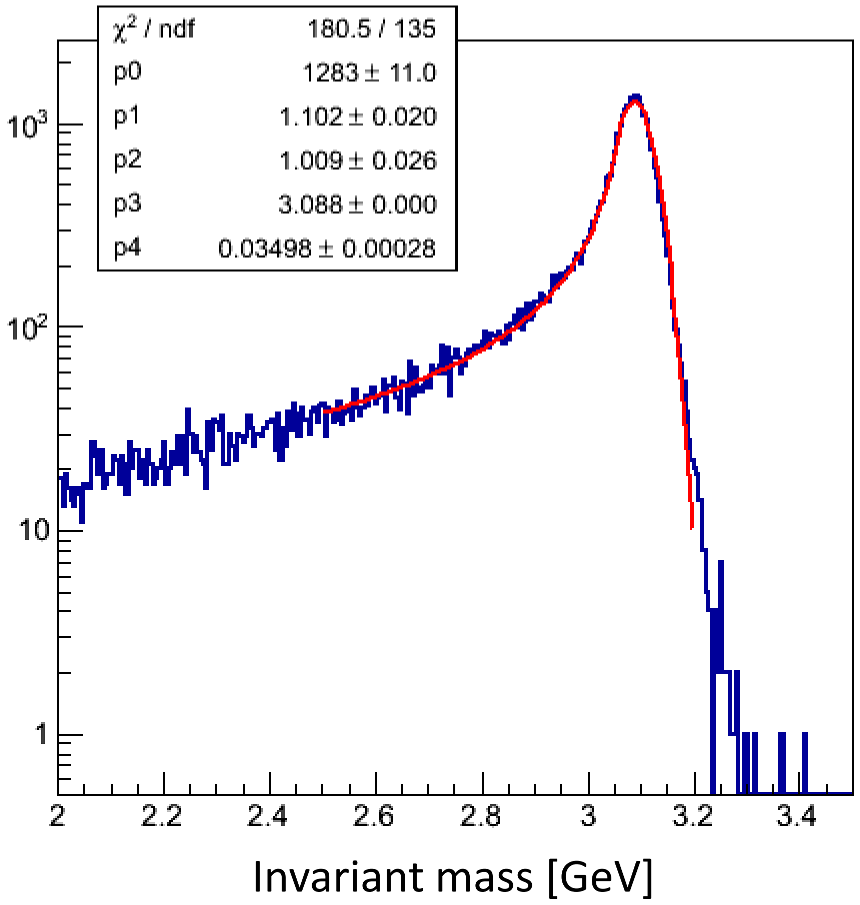
Use pythia8 to produce single J/ψ and single J/ψ coming from B decays.
(particle selection by PHHepMCParticleSelectorDecayProductChain)

Do the same for full p+p events with and without forced bbbar production.

Run through full simulation and reconstruction (MAPS+IT+TPC)

Secondary vertex reconstructed using *PHG4TrackKalmanFitter*

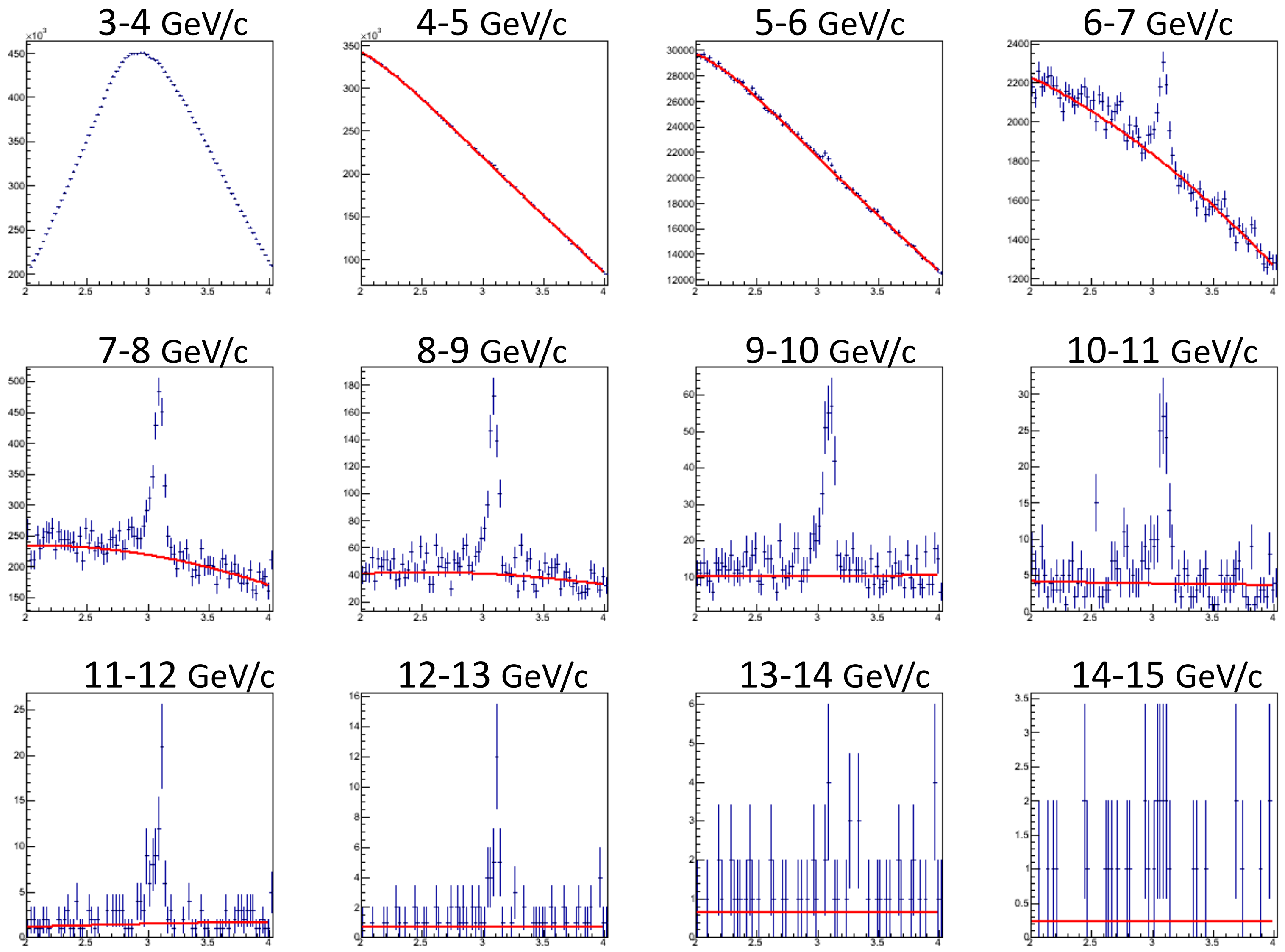
J/ψ mass resolution



For single J/ψ integrated over p_T mass resolution ~35 MeV

Fit with Crystal Ball function

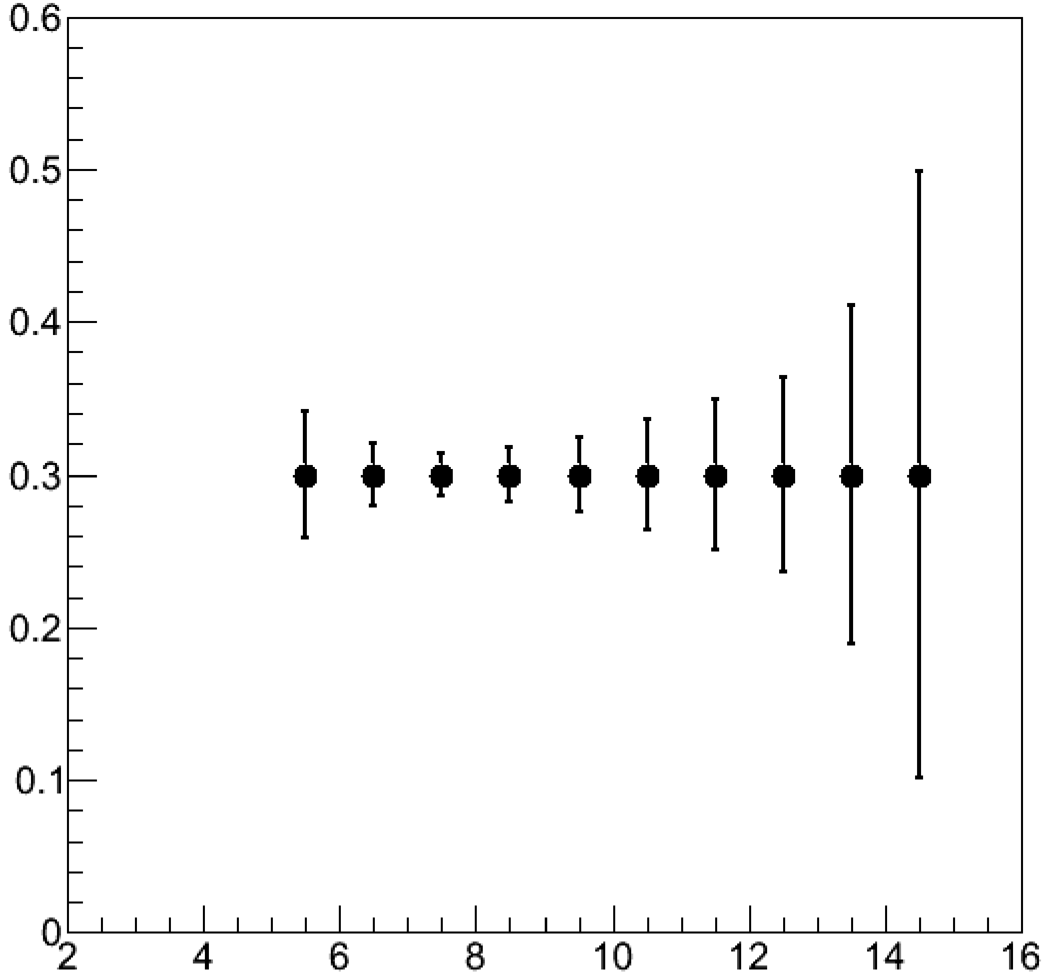
Expected invariant mass distributions



Background is calculated with the code used for Upsilon background.

Combinatorial background only.

Expected R_{AA} statistical uncertainty



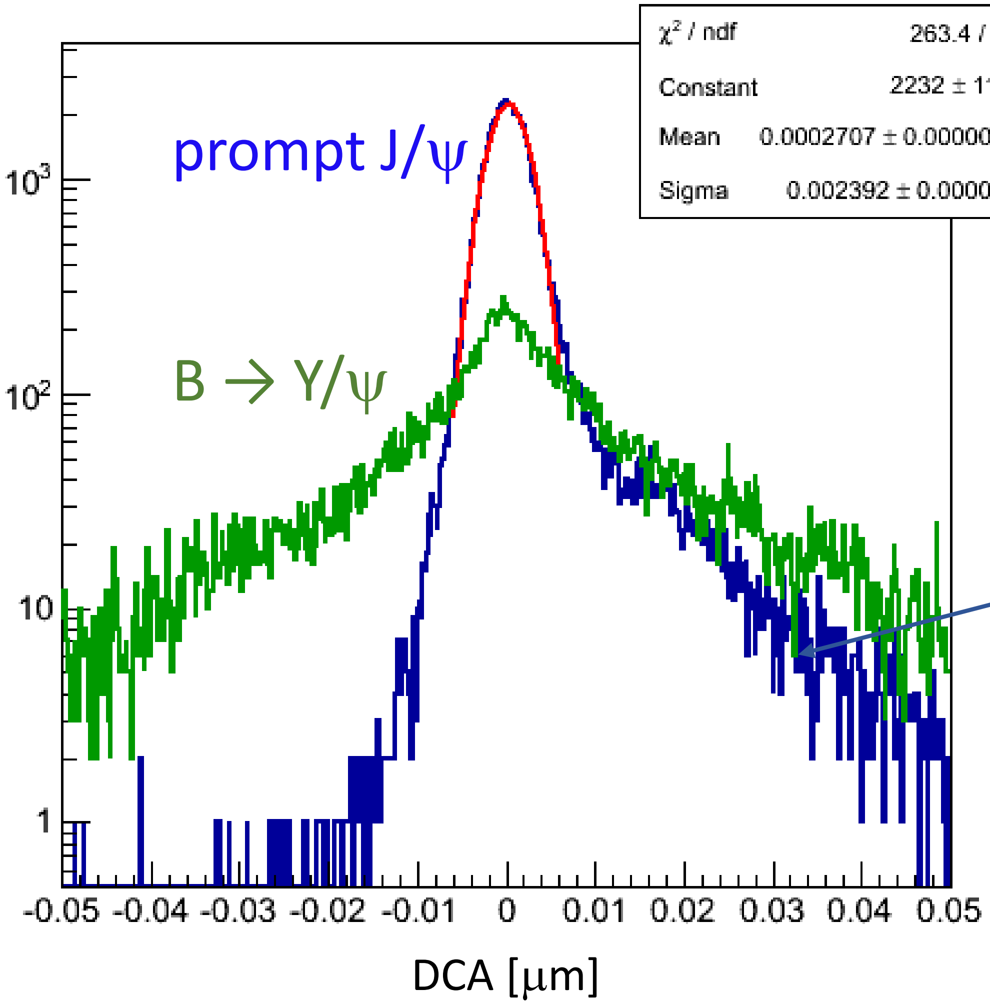
Assuming that p+p uncertainty is negligible.

Maybe we can get a measurement in 4-5 GeV bin, but systematics related to how well we know the background will dominate there.

B $\rightarrow$ J/ψ

Pythia8 simulation with forced bbbar production and forced decay of B-mesons to J/ψ. J/ψ's are forced to decay to electrons.

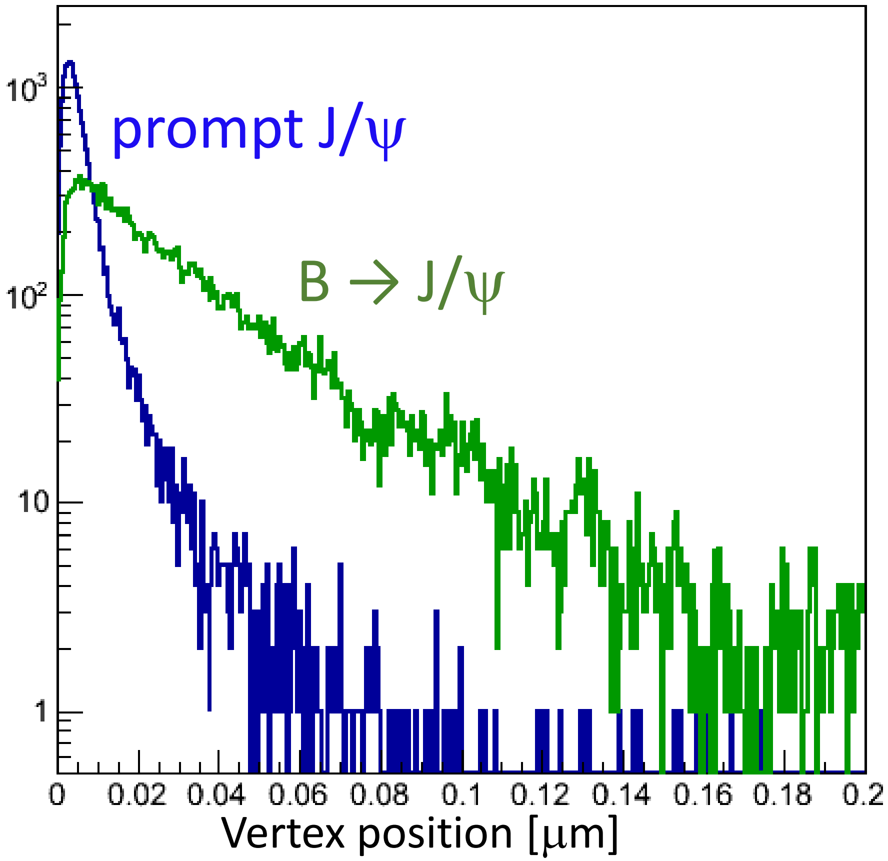
B → J/ψ DCA resolution (single J/ψ)



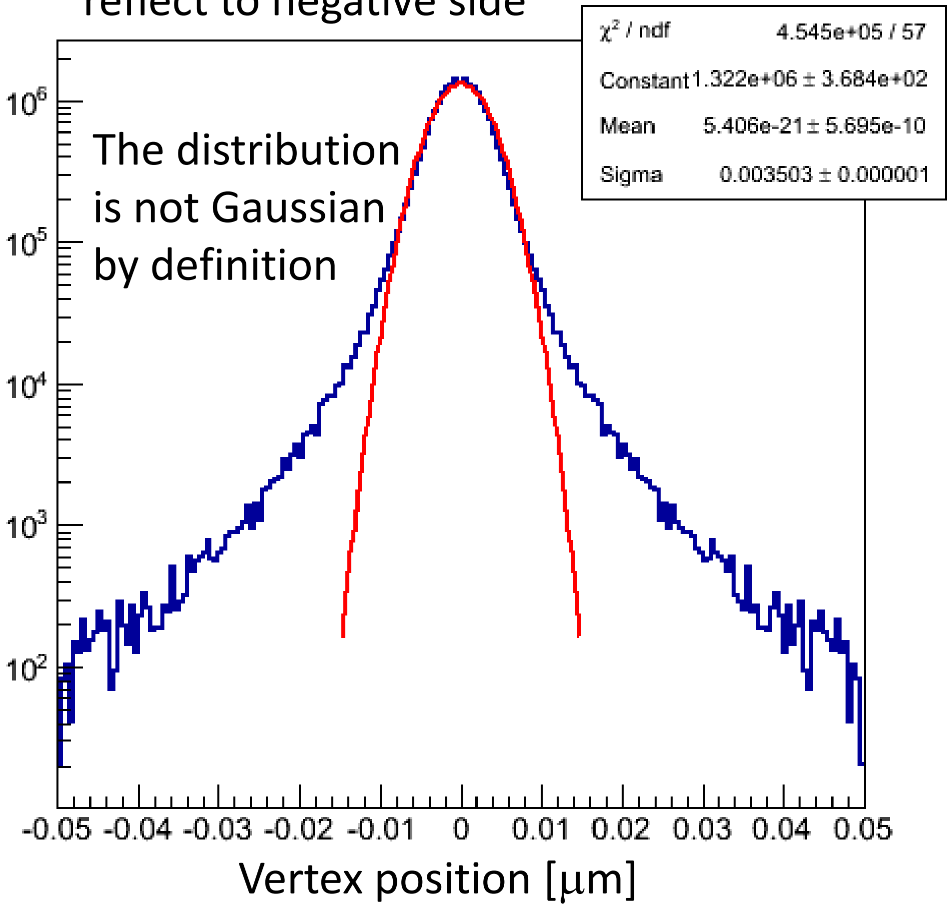
For "single" electrons integrated over p_T DCA resolution is ~24 μm (assuming that primary vertex will be determined with much better accuracy?)

Energy loss by electrons (low mass tail).

B → J/ψ displaced vertex distribution



Fill histogram with weight 1/R and reflect to negative side



For single J/ψ integrated over p_T displaced vertex resolution ~35μm assuming that the primary vertex will be determined with much better resolution.

Enhancing B $\rightarrow$ J/ψ sample and reducing background

To separate J/ψ coming from B-masons from prompt J/ψ we can use either DCA distribution unfolding (like PHENIX) or we can use displaced vertex distribution unfolding.

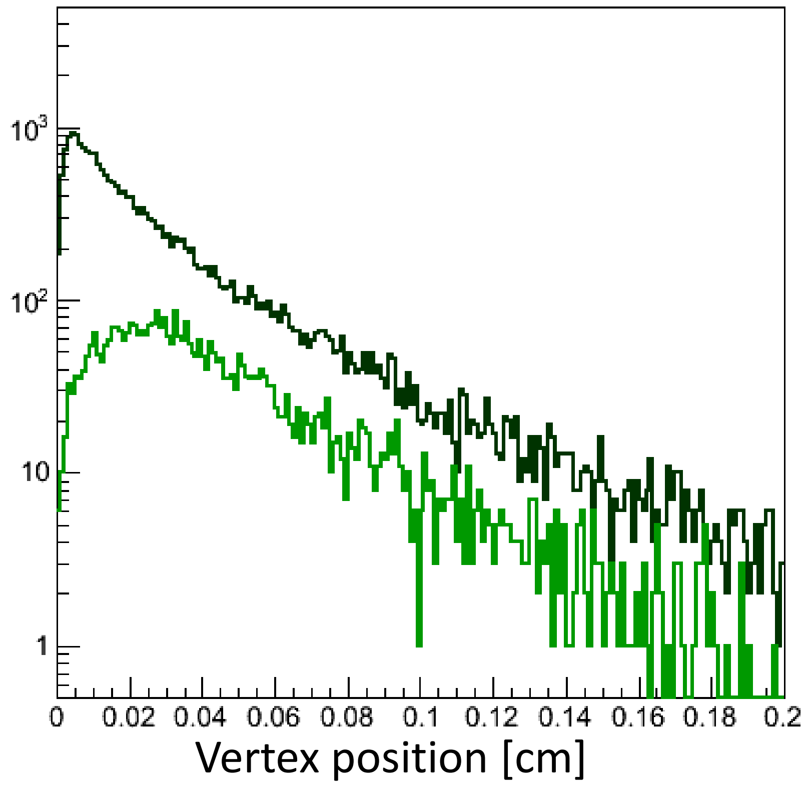
Applying DCA > 85 μm cut keeps ½ of J/ψ from B, but kills 93.9% of prompt pairs (rejection factor = 16.3)

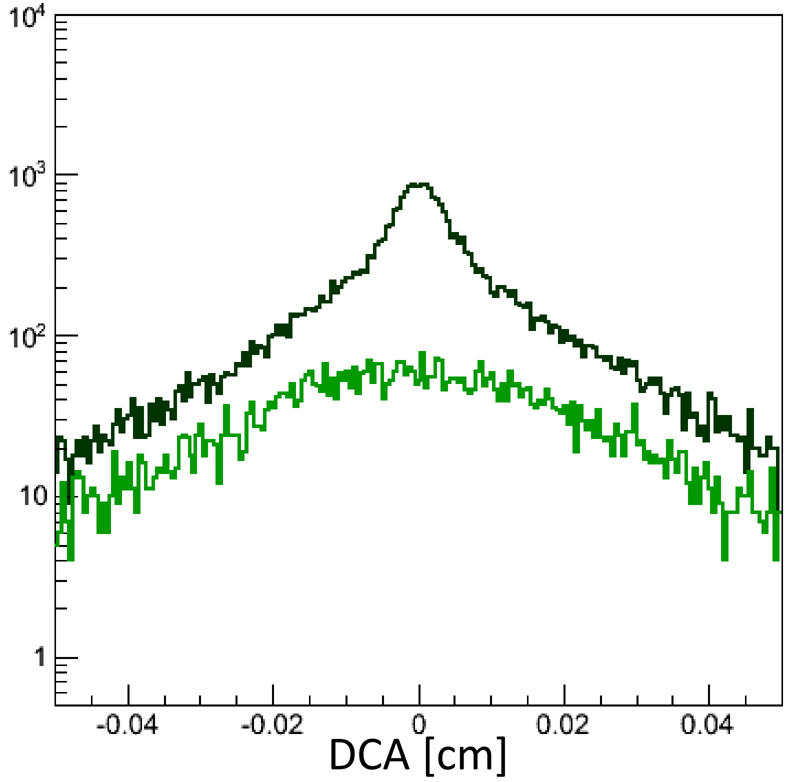
Applying secondary vertex > 185μm cut keeps ½ of J/ψ from B, but kills 95.7% of prompt pairs (rejection factor = 23.3)

Full p+p events with B → J/ψ

Two approaches (particle p_T > 1.0 GeV):

- Select electron candidates (E/p>0.5) and calculate displaced vertex for opposite sign pairs (very dark green). Then choose pairs with inv. mass > 2 and < 3.5 GeV
- Run recursive KalmanFitter algorithm ("avr-smoothing") on the whole event (green) Then select vertices with two opposite sign tracks with inv. mass > 2 and < 3.5 GeV



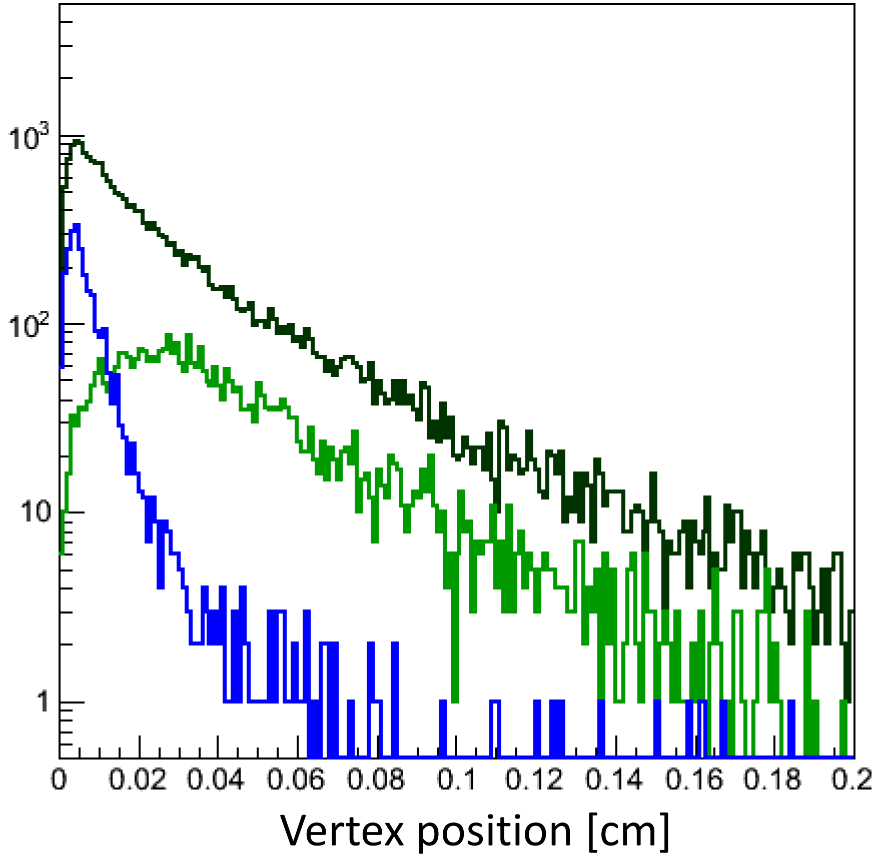


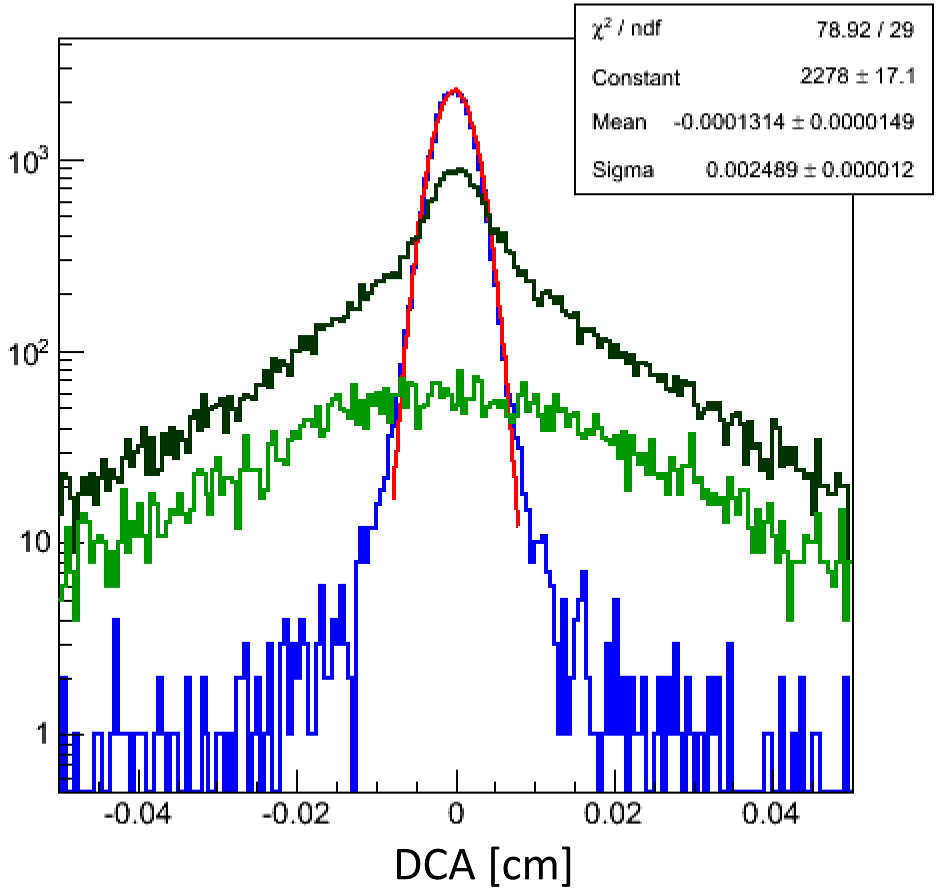
Comparison to p+p background

Same plots with background from Min. Bias p+p events (blue).

Background is for opposite sign pairs with particle $p_T > 1$GeV (no eID cuts)

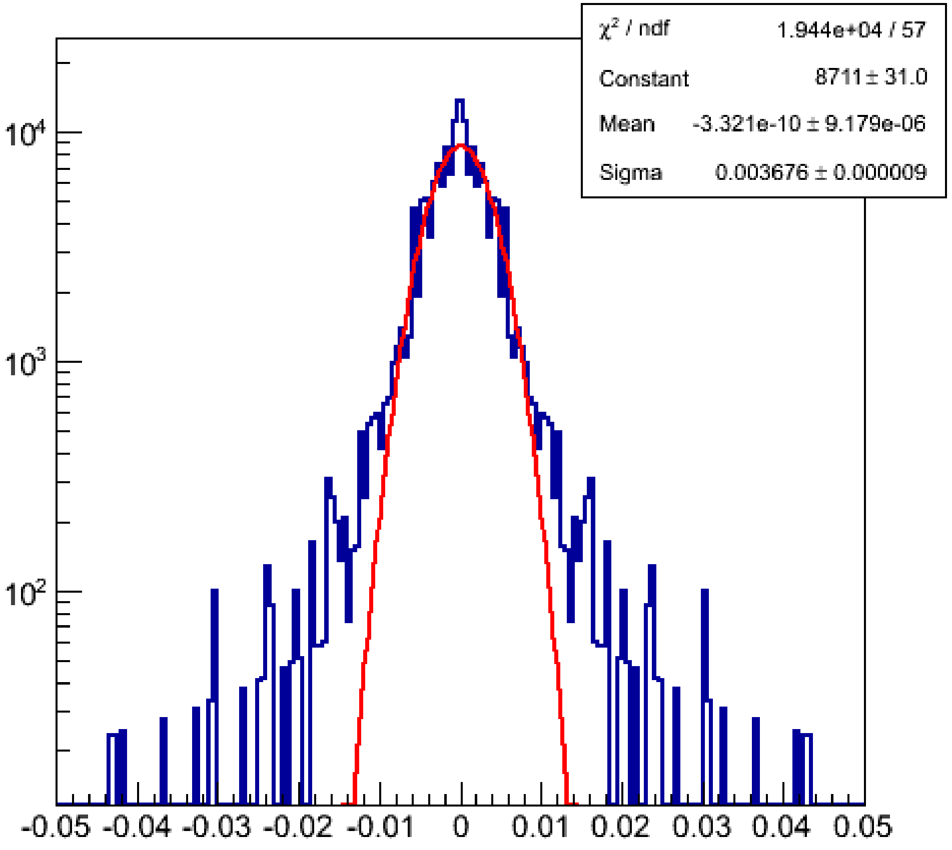
DCA resolution is same as for single J/ψ





Displaced vertex resolution in p+p

Select opposite sign pairs with particle p_T > 1 GeV/c. No PID.
Vertex resolution is almost unchanged compared to single J/ψ

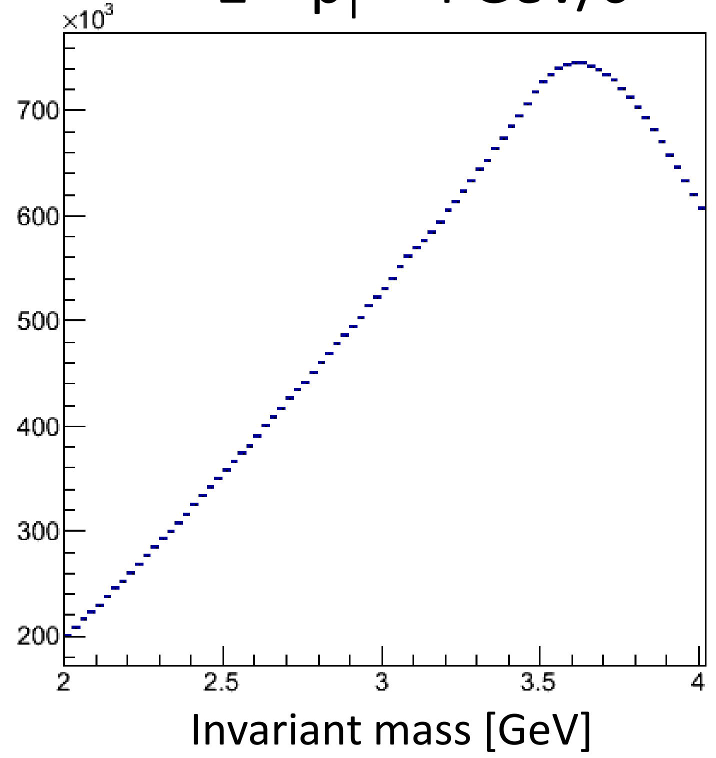


Displaced Vertex resolution [μm]

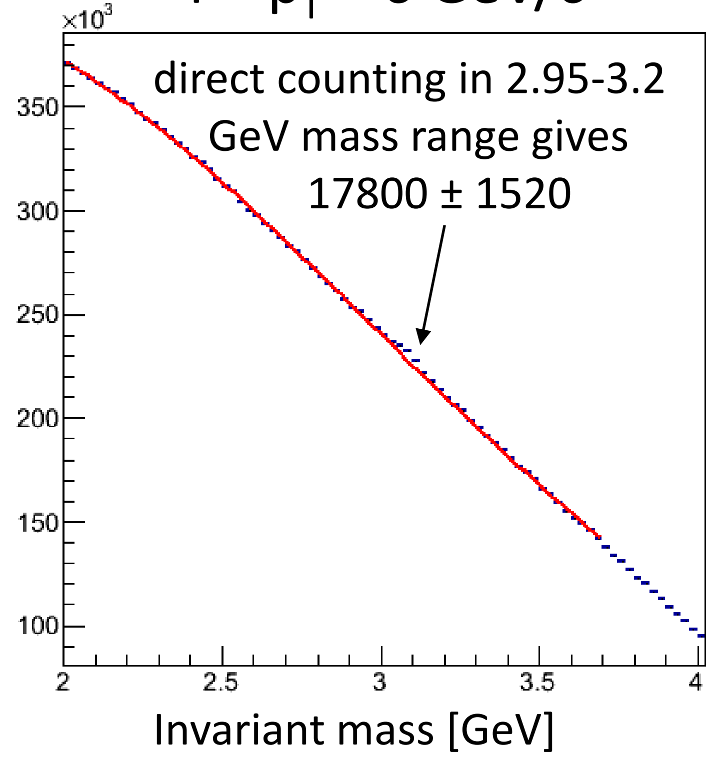
Backups

Expected invariant mass plots

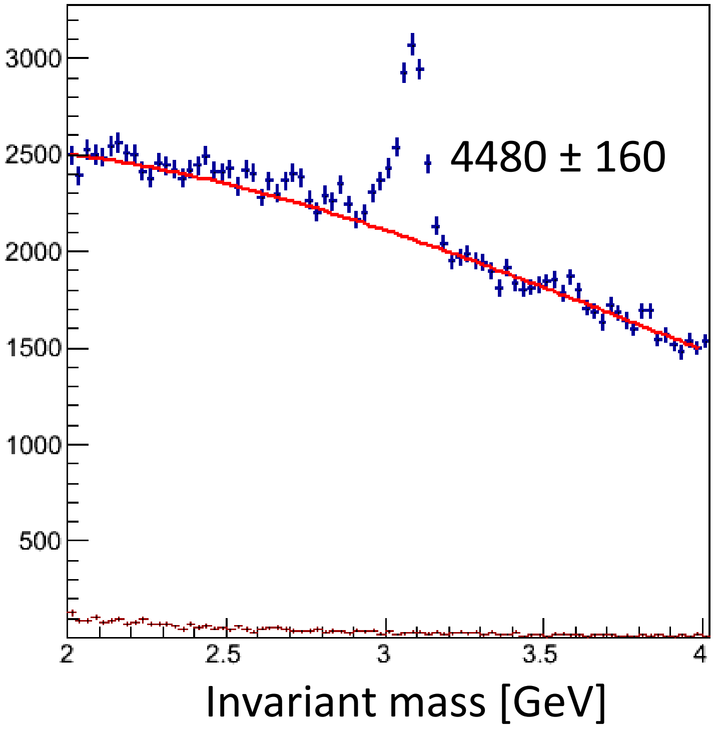
$2 < p_T < 4$ GeV/c



$4 < p_T < 6$ GeV/c



$6 < p_T < 10$ GeV/c



Will make finer p_T binning and calculate R_{AA} uncertainty.